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THE MANSON IMPACT STRUCTURE, A POSSIBLE SITE FOR A CRETACEOUS-TERTIARY (K-T) BOUNDARY IMPACT; J. B. Hartung, Solar System Assoc., Des Moines, IA, M. J. Kunk, U. S. Geol. Survey, Reston, VA, and R. R. Anderson, Iowa Dept. Nat. Res., Geol. Survey Bureau, Iowa City, IA

The Manson impact structure, about 35 km in diameter, is the largest impact crater recognized in the United States. Its center is located near the town of Manson, 29 km west of Fort Dodge, Iowa. The structure is not well known geologically because it is covered by tens of meters of glacial deposits. What is known about the structure has been learned mostly from the study of water well cuttings. At Manson the normal Phanerozoic and Proterozoic sedimentary rocks have been replaced by centrally uplifted Proterozoic crystalline rocks that are representative of the normal basement in this part of Iowa. This central uplift is surrounded by completely disrupted rocks which are roughly encircled by peripherally faulted and slumped sequences of normal sedimentary strata (Figure 1). Radially outward normal sedimentary strata are uplifted slightly. Manson, once interpreted as a cryptovolcanic structure (1,2), is now considered an impact structure based on its circular shape, its central uplift and the presence of multiple intersecting sets of shock lamellae in quartz grains from the central uplift (3). A schematic cross section giving our interpretation of the Manson structure is shown in Figure 2 (4).

$^{40}Ar/^{39}Ar$ age spectrum dating results for a microcline separate from the Manson 2-A core in the central uplift are shown in Figure 3. This spectrum is interpreted to indicate a nearly complete degassing of the microcline at the time of the Manson impact. Although the age spectrum is slightly complicated by the presence of extraneous argon in the low-temperature fractions (fractions 1 to 3), it suggests an age of about 66 Ma for the Manson structure (fractions 4 to 7). The remainder of the gas released climbs in age with increasing temperature of release. This pattern of the age spectrum is interpreted to represent diffusional loss due to reheating at the time of the impact and during subsequent cooling. Therefore, the 66-Ma age (fractions 4 to 7) represents a maximum for the time of the impact.

Shocked quartz grains, present in the iridium-bearing layer at the K-T boundary throughout the world, have a significantly larger size and are more abundant in the western interior of North America than elsewhere in the world. Furthermore, shocked feldspar and granitic fragments are found at the K-T boundary in North America. These observations indicate the K-T boundary impact must have penetrated continental crust in North America (5). The Manson impact involved continental crustal material and is the only one known in North America with an age indistinguishable from that of the K-T boundary.

The similarity in the times of the K-T boundary and the Manson impact may be due to chance. The probability of coincidence by chance (P) depends upon uncertainties in the boundary and impact ages (Δt) and the production rate of impacts (R) and is given by: $P = 1 - e^{-R(\Delta t)}$. For example, if the production rate of 35-km-diameter-and-larger craters in North America is 2×10^{-8} yr^{-1} (6), and if the combined uncertainty in the boundary and impact ages is 2×10^{6} yr, the probability of a simultaneous impact and K-T boundary event occuring by chance is 0.04. The probability of such a chance coincidence would be reduced if uncertainties in the ages were smaller.

References

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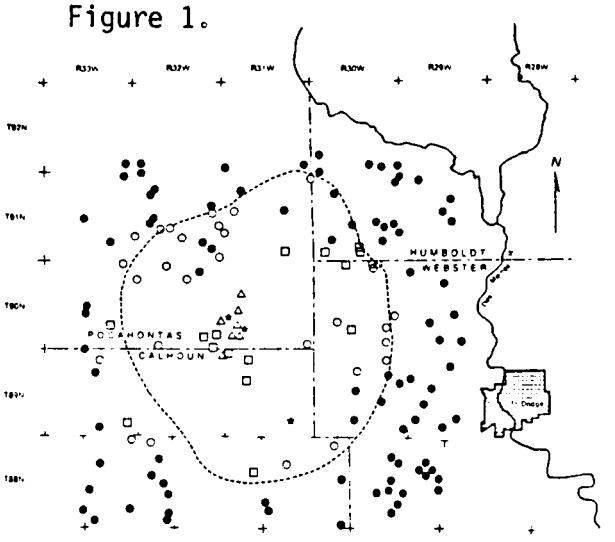
Figure 1.



Map of the area around Manson, Iowa, showing the locations of wells which penetrate a normal Phanerozoic section (●), displaced strata (○), completely disrupted strata ( ), and igneous and metamorphic rocks ( ). Data were collected by Anderson and co-workers. Locations where cores have been obtained are also indicated (✱). The symbols (+) are township corners and are 6 (10 km) miles apart. The dashed line is from Hershey (1969) and is for reference only. It reflects the limits of the structure based on data available in 1969. The data shown are those available in 1987.

Figure 3.

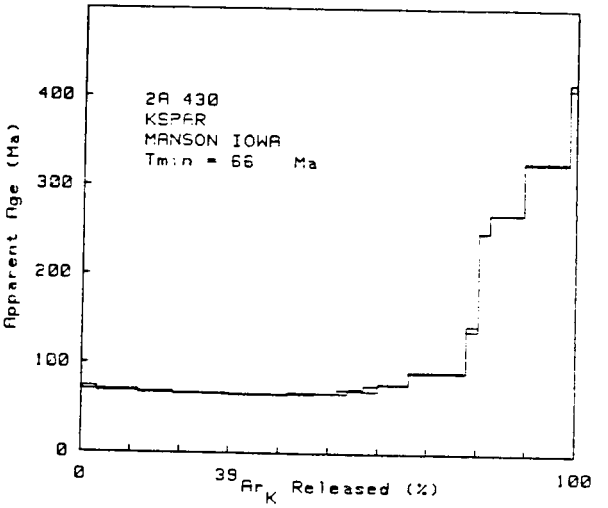


Figure 2.